SOME TALUS CLADONIA FORMATIONS.

BRUCE FINK.

(WITH FIVE ILLUSTRATIONS)

DURING the summer of 1897, while studying the lichen flora of the north shore of Lake Superior, the luxuriance of certain lichens growing on talus attracted attention. The field work was being done for the Minnesota Botanical Survey, and an illustration of one of these unusually large lichens, a cluster of *Cladonia rangiferina* two and one-half feet in diameter and standing fully ten inches high, has already appeared in *Minnesota Plant Life*. During the summer several talus lichen societies were hastily examined, and it soon became apparent that luxuriant growth is by no means the only interesting feature of such plant societies. The object of the survey was taxonomic rather than ecologic, and in a field where many of the lichens were new to the writer, it was found to be practically impossible to secure the data necessary for a study of ecologic problems without seriously interfering with the main object of the expedition. Not until the summer of 1902 was it again found possible to visit the region and secure the desired data. Of course the tali studied in both years all lie within the state of Minnesota. During the season of 1897 tali were observed and somewhat studied along the international boundary between Grand Portage and Gunflint, and farther south at some distance inland in the Misquah Hills, as well as in the Sawteeth Mountains along the shore of Lake Superior. In 1902 efforts were confined to the region along the lake shore, an area not easily equaled in interest as to lichen flora.

On the whole it may be said that such talus lichen societies as will be considered in this paper are among the most interesting of lichen communities. Yet it must be added that they are quite as rare as interesting, or that, growing where they are very difficult of access, they are rarely seen. The composition of such

lichen societies varies with surrounding ecologic conditions. The most apparent of determining factors are the age of the talus, amount of light, shade, and moisture, nature of surrounding vegetation, and edaphic conditions respecting presence or absence of humus upon the lichen-bearing rocks. The age of a given talus is by no means an easy matter to determine. The tali bearing the plant societies under consideration are all surely postglacial, for the old shore lines of Lake Superior extend to or above their bases. So much for a maximum age; now for a minimum. The writer does not know of any igneous or metamorphic rocks, such as those bearing the lichen societies now under consideration, exposed within the last quarter of a century and bearing any considerable number of foliose or fruticose lichens, if indeed any kind whatever. Lichens do take possession of burned-over ground and old stumps to some extent in half the time indicated above, but not the more resistant rocks. Relative age of tali may of course be ascertained to some extent by the age of the trees found growing upon them; but lichens do not gain a foothold on the hard Algonkian rocks rapidly, and the changes in lichen population go on so slowly that little can usually be learned as to exact time involved in the establishment of the lichen population of a given talus. However, tali may be found that are comparatively very young and totally devoid even of the pioneers among rock-inhabiting plants, the crustose lichens; and every gradation of course may be found between this condition and old tali so overgrown with trees and covered with mosses, lichens, and humus that the talus blocks are in places not easily detected. These old tali, for reasons stated elsewhere in this paper, support lichen societies composed for the most part of foliose lichens or fruticose forms, especially the Cladonias, and more commonly these fruticose species in ombrophytic associations. Thus relative age, really of greater interest in ecologic consideration of such slow-growing plants as lichens than absolute age, may be easily ascertained for lichen societies growing upon tali whose conditions as to light or shade, moisture, and surrounding vegetation are similar.

In the field work it was not possible, in the limited time, to

examine a large number of tali. Consequently, three tali bearing quite different Cladonia-formations, growing under different ecologic conditions, were selected for special study.

The first lichen society to be considered in this paper may be designated as a *Cladonia gracilis formation of shaded talus*, and the second and third may be appropriately called *Cladonia rangiferina formations of shaded talus*. The two types are quite dissimilar, as in the first one finds *Cladonia gracilis* and other smaller Cladonias prevailing to such an extent as to be the only small plants to attract the notice of a casual observer; while in societies of the second type *Cladonia rangiferina* and other large closely related Cladonias are, at least on certain small and apparently rather young tali, even more predominant. In some localities, as on the north side of Carlton Peak, may be found tali bearing Cladonia-formations containing both the large and the small Cladonias in about equal proportions. The causes of the differences in composition of these Cladonia-formations are not always easy to trace. Under like conditions as to substrata there may be a succession, the larger Cladonias following the smaller, but quite as often species of Cladonia seem to follow the crustose or the foliose lichens, some species of which disintegrate the rocks sufficiently to form a beginning of humus on which the Cladonias may become established. In instances of this kind the Cladonias that gain a foothold may be the larger or the smaller species according to surrounding ecologic conditions. If the lichen society is surrounded with large trees, containing a good number of conifers, and especially pines, the large *Cladonia rangiferina* and closely related species will predominate. If the trees surrounding or growing upon the talus are small, and especially if devoid of conifers, the smaller *Cladonia gracilis* and other small Cladonias will prevail. If trees are growing upon the talus, of course they are younger than the talus on which they grow, and relative age of such tali may be estimated somewhat accurately by the size of the trees growing upon them. The talus on Hat Point at Grand Portage, to be mentioned again, estimated thus is the oldest one, and the one at Howenstine Bluff (*fig.* 1), to be considered later, is the

FIG. 1—General view of a portion of the talus and face of Howenstine Bluff taken from a point just below the tree line, showing talus blocks, old logs, more or less of the lichens growing over them, and shrubs and trees in various positions.

youngest of the lichen-bearing tali studied. Of course fires have run over certain tali and destroyed the plant life. In such instances the age may, for our purpose, be estimated from the time when the fire destroyed the lichens and other plants; for we are really interested in the age of plant societies.

On the old talus at Hat Point the lichen clusters, in the more shaded spots, are being driven out by the mosses, and the lichen-formation may be said to be scattered.[1] Yet the Cladonias of such societies are the most luxuriant known to the writer. On the tali which seem younger, or which do not present quite so purely ombrophytic conditions, the lichens occupy nearly the whole of the surface. The last formation to be considered below is such a one. Before passing to consider the individual formations it may be well to state that the Cladonias are found so densely congregated upon certain tali because better adapted to the environment than other plants, with which they cannot cope so successfully in the surrounding woods, though the lichens of the tali occur more or less commonly in the woods also. Further it may be said that these Cladonia societies of the tali always attract notice and special interest.

Passing to the consideration of the formations, the one that has been designated the *Cladonia gracilis formation of shaded talus* may be taken up first. The lichen society of this type to be considered especially occurs upon the talus on the north side of Howenstine Bluff, about a mile west of Grand Marais Bay, at Grand Marais, and is the best example of such lichen society known to the writer. The bluff faces to the north and rises forty-five feet above the level ground at the base to the northward. The lower two-thirds of the face of the bluff is covered with talus blocks of various sizes, and the face of the talus rises at an angle of about 35°. The base of the talus lies about forty feet away from the base of the bluff face, and fully one-third and in some places half way up from the base the talus is covered with a more or less dense growth of trees of moderate size, whose branches overhang the talus rather more than half way up to the bluff face. Thus taking into account both the

[1] FINK, B., Minnesota Botanical Studies 2:300. 1899.

trees and the north exposure of the bluff face, the sun can shine upon the talus not more than an hour or two each day. Further, partial shade is afforded by a line of shrubs, six to ten feet high, growing along the bluff face at the top of the talus (*fig. 1*). The face of the bluff above the talus is covered with species of Stereocaulon, Cetraria, Ramalina, Buellia, Usnea, Lecanora, Alectoria, Evernia, and Pannaria, while the talus below is covered with a perfect maze of Cladonias and mosses, with species of Stereocaulon, Peltigera, Sticta, and Parmelia interspersed here and there. The Cladonias have doubtless wandered to the talus from the level woods to the north below and yet more from the south on top of the bluff, and are especially numerous as to individuals and species because such an ombrophytic habitat is well adapted to the development of lichens having erect podetia surrounded by a protective pseudo-cortex of densely interwoven hyphae. These podetia are of course through the cortical hyphae protected against too rapid evaporation of moisture, and thus the Cladonias are able to rise from the substratum in a more or less erect position and successfully compete with the mosses for possession of the talus blocks.

The species and varieties easily detected in an area of the talus one rod square are *Cladonia gracilis*, *C. gracilis dilatata*, *C. cristatella*, *C. verticillata*, *C. verticillata evoluta*, *C. furcata paradoxa*, *C. fimbriata*, *C. fimbriata apolepta*, *C. fimbriata subulata*, *C. fimbriata radiata*, *C. bacillaris*, *C. deformis*, *C. pyxidata*, *C. cenotea*, *C. coccifera*, *C. squamosa*, *C. caespiticia*, *C. uncialis*, *C. rangiferina*, *C. sylvatica*, and *C. alpestris*. Of these the first and its variety (*fig. 2*) are especially abundant, though all but the last half-dozen are common enough. From the tree line to the base the talus is literally covered with Cladonias, of which the one for which the formation is named predominates even more largely than on the portion of the talus above the tree line. On this lower shaded portion of the talus, the Cladonias grow most abundantly on the old logs that cover the greater portion of the base of the talus. Unfortunately, it was found necessary to remove a few of the trees, shrubs, and logs growing upon

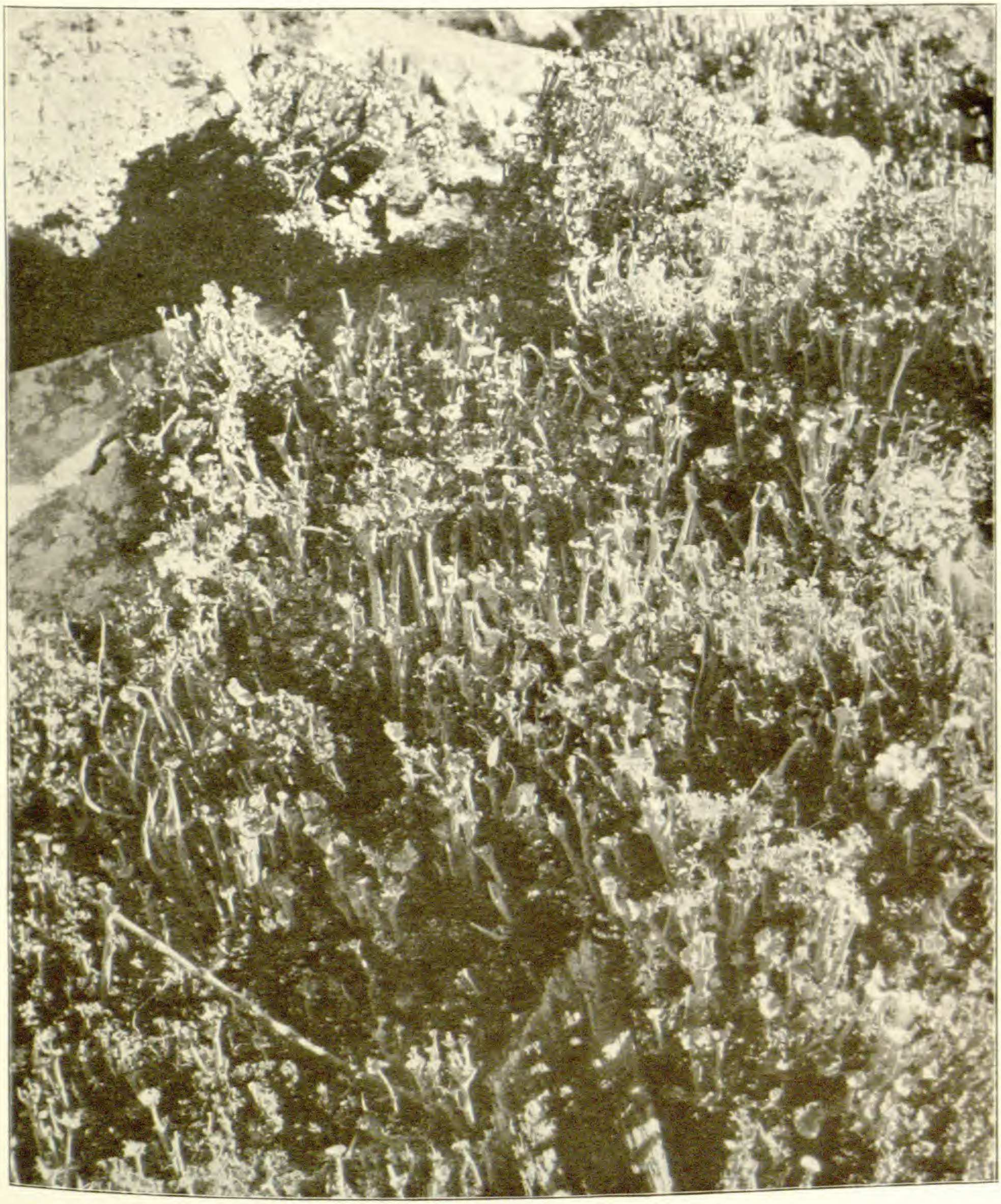

FIG. 2.—Detail of an area of the Howenstine talus one foot square, taken just above the tree line and covered with a dense growth of the most conspicuous plant of the society, *Cladonia gracilis*, and eight or nine other Cladonias in small numbers.

the talus to get a good general view, and it may be said that the presence of old logs upon the talus is an ecologic factor of considerable importance, as these smaller Cladonias are usually abundant on and about such decaying logs in favorable habitats.

It is an interesting fact that such societies of the smaller Cladonias are usually found in regions recently burned over, while those containing the large *Cladonia rangiferina* and its allies are more common in regions not recently burned and containing large conifers, especially pines. There is good evidence that the *Cladonia gracilis* societies may become established in soil-covered burned areas in ten or fifteen years, and the name, *Cladonia gracilis formation*, may be applied to other lichen societies than those of the talus. Frequently, however, the less conspicuous *Cladonia cristatella* or *Cladonia verticillata* predominates in these societies of the soil-covered areas. Finally, it is reasonable to suppose that much longer time would be required for such a plant society to become established upon the talus than upon the soil.

Cladonia rangiferina and its allies are frequently seen wherever conifers grow in the region, but nowhere else in such abundance or luxuriance as on the shaded tali. Botanists have frequently noted the fine Cladonias of Isle Royale in Lake Superior eighteen miles east of Grand Portage, Minn. I have not seen Cladonias growing on tali on the island, but have examined them somewhat under the conifers along the shore line and have seen none equal in size to those of the tali in the Sawteeth Mountains. The writer has studied these somewhat carefully and has found them best developed at Grand Portage and Grand Marais. The *Cladonia rangiferina* formation is best developed on the east side of Hat Point near Grand Portage. The point is about one hundred rods wide at the landward extremity and extends out into the lake somewhat more than a mile, in a southeastward direction, to a lakeward extremity which is only four or five rods wide. To the landward end, Mount Josephine rises about 800 feet above the lake, and from Mount Josephine to the lakeward end the point gradually decreases in elevation as well as in

FIG. 3.—A cluster of *Cladonia rangiferina* nearly three feet in diameter, taken from the Hat Point talus. A portion of a cluster of *Cladonia alpestris* is also prominent in the figure.

width. The ridge of the series of hills extending from Mount Josephine to the extremity of the point lies to the northeast of the central axis of the point so that the descent to the lake level on this side is quite precipitous. A large portion of this northeast side is covered with talus blocks, some of which are twenty-five to forty feet in their longest dimension (*fig. 3*). These blocks are overgrown with a forest of good-sized trees, principally conifers, and the whole talus-block floor is covered with such a growth of lichens and mosses as one seldom sees. During the first visit to the spot in 1897, fields of the larger Cladonias were found which looked at a distance much like the usual illustrations of coral forests. As nearly as I can recall, one such field covered more than an acre. It was almost completely covered with magnificent clusters of *Cladonia rangiferina*, *C. alpestris*, *C. sylvatica*, *C. uncialis*, and *C. amaurocraea*, and formed as beautiful and attractive a lichen community as one can well imagine. Some idea of the luxuriance of the plants may be had when it is stated that clusters were frequently seen from two to three feet in diameter (*fig. 4*). The talus with its great blocks, frequently thirty or forty feet long, and holes between, often twenty or thirty feet deep, is not easy to traverse, and it is not strange that in two days spent on the point in 1902 this wonderful Cladonia forest was not seen. At certain points the perpendicular rock face still remains above the talus and is in places from 100 to 200 feet high. The talus with its great blocks extends from 400 to 700 feet from the ridge or the perpendicular walls above to the water's edge below.

To compensate for failure to find the field of Cladonias above mentioned, a study of a somewhat similar one, though compact instead of scattered, may be presented. This formation may well receive the same name as the one just discussed. It occurs about a mile north of Grand Marais on the south slope of the Sawteeth Mountains. The formation is most luxuriant toward the more shaded basal portion of the talus (*fig. 5*), which is about sixty feet long and rises at an angle of approximately 40°. The characteristic plants of the society are *Cladonia rangiferina*, *C. alpestris*, *C. sylvatica*, *C. amaurocraea*, *C. uncialis*, and *Stereo-*

FIG. 4.— Small portion of the talus at Hat Point. The upper talus block is about 35 feet long, and its face and upper surface was found covered with Cladonias, other lichens, trees and shrubs, ferns and mosses. Cladonias are numerous on the smaller blocks in foreground.

caulon paschale. The more shaded basal half of the talus is so covered with these plants that a casual observer would scarcely notice the smaller and less numerous plants of the community. Yet a little closer observation brought to light a few ferns, quite a sprinkling of mosses, a half-dozen species of smaller Cladonias, and a few species of the foliose Nephroma, Peltigera, Parmelia, and Umbilicaria. On account of the less shaded conditions toward the upper part of this southward exposed talus, the Cladonias characteristic of the society are there less numerous and give way in part to the above-named foliose lichens and a number of species of the crustose Lecanora, Biatora, Buellia, and Lecidea. The talus sloping to the south is not, as hinted above, well shaded toward the upper part where the limbs of the large trees growing upon the lower part do not overhang. Of course the trees above a talus with south exposure do not furnish any considerable amount of shade. Consequently, rock decay has not gone on so rapidly toward the top of the talus, and neither this condition nor the lack of shade has been so favorable for the development of the erect-growing Cladonias. Hence there are present a large proportion of the crustose lichens upon the upper portion of the talus, these plants, in their closely adnate position upon the rocks, being better adapted to the more exposed portion of the talus because they easily hold the moisture between their lower surfaces and the rocky substratum and also readily absorb moisture from the rocks. The size of the trees would indicate that this talus is older than the one first considered and about two miles distant, and whether this is true or not, there is every indication that a fire ran over the one at Howenstine Bluff at no very distant day and killed the plant life of the spot so that the present growth is comparatively recent. The presence of a good sprinkling of old woody débris upon the talus now under consideration (*fig. 5*) shows that this condition alone does not indicate the presence of a Cladonia society composed of the smaller species. In this instance doubtless the *Cladonia rangiferina* society has succeeded the *Cladonia gracilis* community as the trees became larger, furnishing more ombrophytic conditions, and as the poplars and other deciduous trees

FIG. 5.—View of the talus on Sawteeth mountains, taken from a point 25 feet above the base of the talus and just above the tree line. Cladonias are conspicuous in the foreground.

gave way to a large extent to conifers, especially pines and cedars. In addition to the ecologic factors already noted, it may be said that protection from wind is a factor aiding in the development of the *Cladonia rangiferina formations*, as the plants of such societies can hardly endure the effects of strong winds.

It may be readily inferred from certain statements in this paper that it is by no means the intention to convey the impression that the Cladonia lichen societies are the only ones to be found upon tali. Other talus lichen communities, though not so striking in appearance, would doubtless prove to be quite as interesting if studied in detail. Such lichen societies as have been considered in the present paper doubtless occur in various portions of North America, especially in mountainous regions, and comparative studies as to ecologic conditions, adaptations, and species contained in the formations in various portions of our territory would be both interesting and instructive.

UPPER IOWA UNIVERSITY,
Fayette, Iowa.